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SOME RECENT PRACTICAL MISCONCEPTIONS ABOUT THE STATE OF THE ART OF NETWORK ALGORITHMS

by

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13. ABSTRACT

The purpose of this technical note is to correct several errors and misconceptions in a recent article appearing in Operations Research concerning the state of the art in network solution methods and their computer implementations.

14 KEY WORDS	LINK A		LINK B		LINK C	
	ROLE	WT	ROLE	WT	ROLE	WT
Assignment Problems						
Manpower Planning Problems						
Networks						
Transportation Problems						
Personnel Assignment Problems						
Computation Testing						
Mathematical Programming						

ABSTRACT

The purpose of this technical note is to correct several practical misconceptions about the state of the art of network solution methods and their computer implementations, as represented in a recent article in Operations Research.

The article "Bench Marks Comparing Transportation Codes Based on Primal Simplex and Primal-Dual Algorithms" by Richard S. Hatch [7] contains several important practical misconceptions about the state of the art of network solution methodology and its computer implementations. The purpose of this note is to correct some of the more prominent misstatements that have led to some confusion among researchers and practitioners and have caused a number of them to contact us asking for clarification. These include invalid comparisons of machine customized software with machine independent software, of special purpose codes with general purpose codes, as well as omission of major considerations relevant to practical implementation.

The article of [7] purports to compare primal simplex and primal-dual network algorithms that are specialized to transportation and assignment problems. This is, in fact, not done. Instead, two specialized primal-dual codes developed by Decision Systems Associates, Inc. (DSAI), tailored to solve uncapacitated assignment and transportation problems, are compared with our more general primal simplex network codes PNET and PNET-1 [4, 6]. These latter computer codes handle transshipment networks with any degree of capacitation and without restriction to bipartite structures. Such an attempt to compare special purpose methods and general purpose methods, without acknowledging their different solution capabilities, is highly misleading. To compound the confusion, the Hatch article quotes our transportation reference [5] as

though it were the source article for PNET and PNET-1, when in fact [5] has nothing to do with these codes, and the code of [5] was developed three years prior to the development of PNET and PNET-1.

Disregarding this difficulties, the conclusions of [7] are still somewhat tenuous. That is, even in the absence of special streamlining to handle bipartite structures, and ignoring further computational savings that can be achieved by eliminating capacitation, our capacitated transshipment code ARC-II, reported in [2] compares favorably to the DSAI codes when applied to the restricted assignment and transportation structure that the latter were designed to solve. In fact, the solution times of ARC-II, on the same computer and the same compiler, are better than those of the DSAI codes on six of the ten problems benchmarked in the Hatch article against PNET-1.

Another factor whose importance is neglected in [7] and which further invites misleading inferences, is the issue of machine customized software versus machine independent software. The computational times reported in [7] are for computer programs run on the CDC-6600. CDC allows the user to include assembly level (COMPASS) statements within the FORTRAN deck. If one takes advantage of this, it is easy to produce a code that is a lot faster than an all FORTRAN code. For example, if we replace approximately 15 of our statements with COMPASS statements, we can substantially reduce our times. Even without these changes, if we simply arrange all of our DO LOOPS so that they fit entirely within the stack registers on the CDC 6600, we can cut our times by at least 25%.

In short, it does not make sense to "compare" times based on exploitation of a particular machine configuration with times that are not based on such an exploitation.

Members of the DSAI staff tell us they have spent a good deal of time optimizing code performance on the CDC 6600. Also, in the solution efforts reported in [7], the DSAI group changed both the computer program and the compiler when running on different problem structures in order to exploit the CDC 6600 hardware and take advantage of special bit-instructions available on the Extended (Opt. 2) FORTRAN compiler. In contrast, we do not utilize such machine customizing when reporting times in the literature, yet the article [7] implies that we do. We do, however, machine customize our codes when they are being used by an industrial or government group on a particular machine for a specific application, but we are careful not to report these substantially accelerated times as comparable to those obtained by our all FORTRAN codes. (It should be noted that the machine independent feature of these FORTRAN codes, while reducing the solution speed, produces an important compensation. Specifically, the resulting portability has enabled these codes to be installed on most major name brand computers at universities and companies around the world, in large scale and minicomputer applications.)

In addition to the foregoing, the Hatch article conspicuously omits consideration of the issue of memory requirements. The amount of computer memory space required by the code is extremely important to its practical usefulness. This is evident not only in the case of running

on computers with limited memory, but also in the case of running truly large-scale applications with an in-core out-of-core, when the ability to keep the major "working components" of the code and data within central memory can have a dramatic effect on solution speed. Special purpose network implementations of the simplex algorithm currently require the least computer memory of any existing network computer codes. In fact, this advantage of reduced memory requirement has caused a number of major firms that had used primal-dual and out-of-kilter codes for at least ten years to switch to special purpose simplex codes. (A recent advance promises to change the superiority of simplex codes in this regard. We have developed a new type of extreme point assignment algorithm [1], which requires only about half the storage required by the simplex algorithm for assignment problems.)

Hatch is undoubtedly aware of the importance of memory requirements in any comparison of computer codes and of the superiority of the primal simplex codes along this dimension, but he does not refer to such considerations in [7]. Prior to [3], Hatch's earlier article [8] put considerable stress on the significance of these requirements, claiming that primal-dual codes were superior to special purpose simplex codes in memory requirements.

In closing, we would like to indicate that it is not our intent to imply that either Mr. Hatch or his associates have not done an excellent job of developing highly efficient codes of the primal-dual genre. Quite the contrary is true. Rather, we simply wish to point out those misconceptions about the state of the art in network solution methods that invite invalid conclusions about the relative merits of alternative types of network codes.

REFERENCES

1. R. S. Barr, F. Glover, and D. Klingman, "The Alternating Basis Algorithm for Assignment Problems," Research Report CCS 263, Center for Cybernetic Studies, University of Texas at Austin, Austin, Texas 78712 (1976).

2. R. S. Barr, F. Glover, and D. Klingman, "Enhancements to Spanning Tree Labeling Procedures for Network Optimization," Research Report CCS 262, Center for Cybernetic Studies, University of Texas at Austin, Austin, Texas 78712 (1976).

3. F. Glover and D. Klingman, "Important Practical Misconceptions of Optimizing Large Scale Assignment and Transportation Problems," presented at the ORSA/TIMS Conference in Puerto Rico, Oct. 16-18, 1974.

4. F. Glover, D. Karney, and D. Klingman, "Implementation and Computational Study on Start Procedures and Basis Change Criteria for a Primal Network Code," Networks, 4, 3, 191-212 (1974).

5. F. Glover, D. Karney, D. Klingman, and A. Napier, "A Computational Study on Start Procedures, Basis Change Criteria, and Solution Algorithms for Transportation Problems," Management Science, 20, 5, 793-819 (1974).

6. F. Glover, D. Klingman, and J. Stutz, "Augmented Threaded Index Method for Network Optimization," INFOR, 12, 3, 293-298 (1974).

7. R. S. Hatch, "Bench Marks Comparing Transportation Codes based on Primal Simplex and Primal-Dual Algorithms," Operations Research, 23, 6, 1167-1171 (1975).

8. R. S. Hatch, "Optimization Strategies for Large Scale Assignment and Transportation Problems," presented at the ORSA/TIMS Conference in Puerto Rico, Oct. 16-18, 1974.